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Instructional Design and Learning Theory on the Development of C++ Programming Multimedia Content

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Abstract

This paper discusses on the possibility of taking advantage of the well-served Gagne's theory of learning and combining it with the benefits of instructional design. Such potent combination can surely be extended further with the integration of advance multimedia is undoubtedly helpful in today's education realm. The best off all these factors may have positive impact on the teaching and learning scenario. Hopefully it has an optimistic bearing on the study of computer programming for non-computer science students when an interactive multimedia application is developed based on Gagne's theory of learning.

Keywords: Theory of learning; interactive multimedia application; illustrative C++ programming.

1. Introduction

The advent of information technology has become an integral part towards the study of programming. In relation to that, a lot of efforts and steps have been taken to increase the students' quality of learning and understanding in programming courses (ATUR '03, Mohd Khalit

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Othman,2003)(http://www.ftsm.ukm.my/programming/prosiding-atur03.html). The study of C++ programming is not entirely easy to implement with the common teaching and learning methods (Norasykin,2005). The development of multimedia content allows the integration of multiple multimedia elements that could ease the study and understanding of programming techniques thus enriching the learning environment.

A web development study through usage analysis on the utilization of web based learning methods of C++ programming indicates that one way of heightening the learning experience must include a graphic based multimedia element (Norasykin Mohd Zaid,2008). The objective of this study is to design a method in developing multimedia electronic content for the C++ programming course.

2. Problem statement

e-Learning transforms the teaching and learning process into an effective process. The in-class repetitive exercise aims to generate the skills on using it thus the student's acquisition can be supported and heightened through the computer and internet based learning. Students can revise, understand new material, evaluate mastery level, attempt exercise, stimulate their mind and augment their skills.

Therefore, the lack of systematic teaching and learning (T&L) materials on programmingspecifically those that are based on Gagne's theory has rendered the need to conduct a comprehensivestudy.The study should look into:

- the preparation of suitable teaching and learning materials in accordance to the course content
- the systematic, efficient and effective transfer of knowledge mode
- supplement the less-interested students' need in learning programming
- the way an acquisition process can be assisted and enhanced in class
- becoming a reference and a source for various activities in tandem with the course

3. Multimedia in Education

Multimedia is a combination and integration of texts, graphics, audio, animation and video. Currently the interactivity concept is given great attention so much so it is becoming as a must criteria in a software or an application. The term multimedia is also experiencing an evolution where it is also known as interactive multimedia to denote that the interactivity is another element to focus in any multimedia application (Jamalludin Harun, 2005).

A variety of definitions and understandings has been set forth but generally, there are two main characteristics that should be considered where multimedia definition is concerned. The characteristics are:

- multimedia refers to a computer based information presentation through the combination of
- multiple media such as texts, graphics, audio, animation, video and othersmultimedia is a system that allows independent access including interaction between acomputer and a user

Therefore the general definition of multimedia accepted by the mass is:

"an interactive communication process based on the use of computer technology which includes the use of audio visual media such as texts, graphics, audio, video and animation."

(Jamalludin Harun, 2005)

The advancement of multimedia technology can be literally seen and felt in the presence of acomplete computer set equipped with the CD-ROM drive, audio card, video card and speakers. The rate of household with a computer increases manifolds every year. A 1992 study in the Unit-ed Statesof America states that the registered number of multimedia products on CD increases from 5000 unitsto 15000 units

in 1996 and running into the thousands in early 2000. A similar landscape occurs inMalaysia where a lot of local talents and companies produce and distribute multimedia applicationconforming to the local cultural sense especially in the education, training and entertainment field(Jamalludin Harun, 2005).

In the education domain, multimedia technology is able to positively affect the teaching andlearning process. This approach eases the transfer of static information into an interesting, dynamicand interactive way. Multimedia with its dynamics will breathe a learning concept as a result fromthe combination of education and entertainment called edutainment. The content transformation fromtraditional to games and entertainment based will present an entertaining and attention grabbinglearning process for the students. Therefore, multimedia can help in easing the process of knowledgetransfer effectively especially for distance learning program or part time.

Jamalluddin Harun (2001) had come up with systematic and interesting models in thedevelopment of multimedia content. The development of multimedia applications need to undergoprecise process from the planning and analyzing the needs of the application, designing, developing,testing as well as evaluating the application.

There are a few researches on the interactive teaching and learning materials of C++Programming multimedia content. Due to this lack of research and programming e-materials basedon the Gagne's learning theory phenomena in the form of multimedia content, the researchers took aninitiative step in aligning the instructional design and development theory with Gagne's theory. Theinstructional design and development reflects the outcomes' enhancement in the programmingcourses.

4. Research framework

This research portrays the process of constructing the multimedia content according the Gagne'stheory as to develop the e-materials for C++ programming course.

This research is divided into 3 parts that are input, process and output using the ADDIE modelwhich comprise of 5 phases – **A**nalyze, **D**esign, **D**evelopment, **I**mplementation and **E**valuate.Gagne's theory is used to obtain a cognitive teaching and learning concept. Analyze and design phaseare categorized as input, development and implementation phase are categorized as process, andevaluate phase is categorized as output. In the evaluation phase, the research will identify theeffectiveness of developing the instructional design using formative theory. The research conceptualframework on the instructional design of C++ programming e-material based on Gagne's theory isportrayed in the following figure:

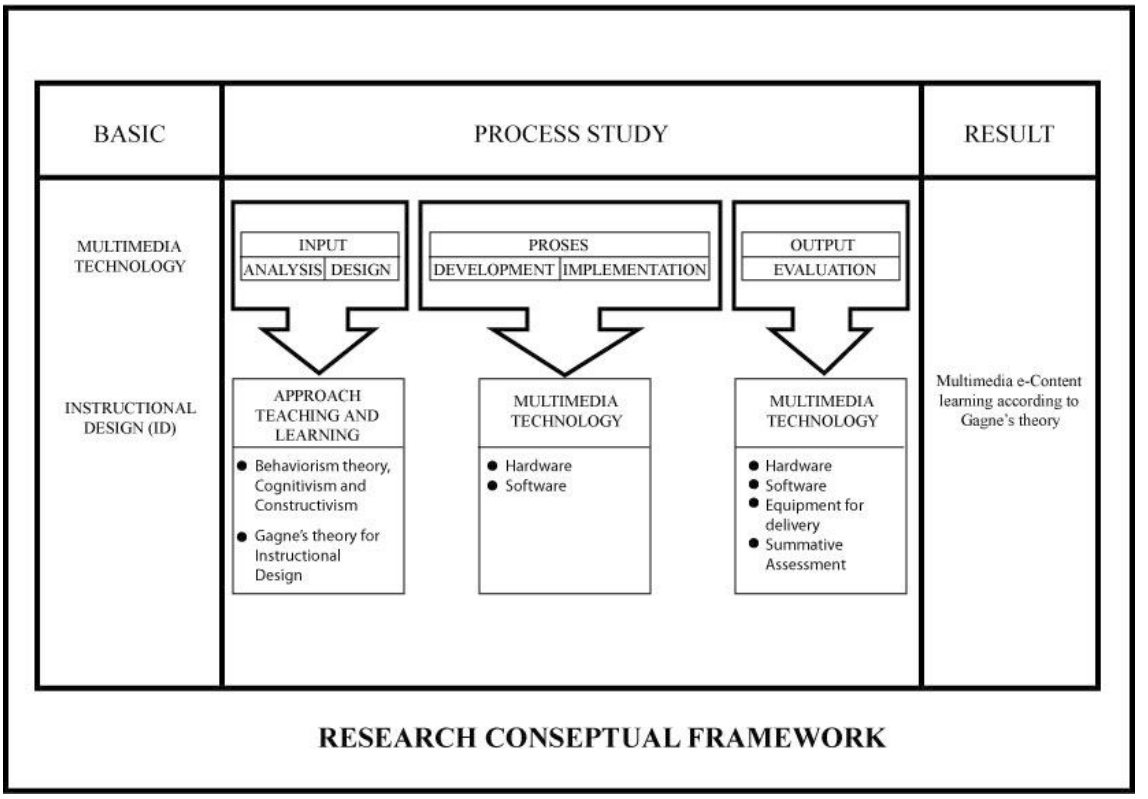

Fig. 1. Research Conceptual Framework

5. Research methodology

Several instructional design models are referred to in designing and developing a multimedia content application, which are as follows.

- ADDIE Model
- ASSURE Model
- Hanaffin and Peck Model
- Dick and Carey Model
- Robert Glasea Model

In the instructional design and development process, the multimedia content developer can either use one instructional design model or a combination of elements in several model discussed before. However, as far as this paper is concerned, ADDIE model will be referred to.

5.1. ADDIEModel

This model is among those used as the basis to the other instructional design models. Generally it involves with several processes such as follows:

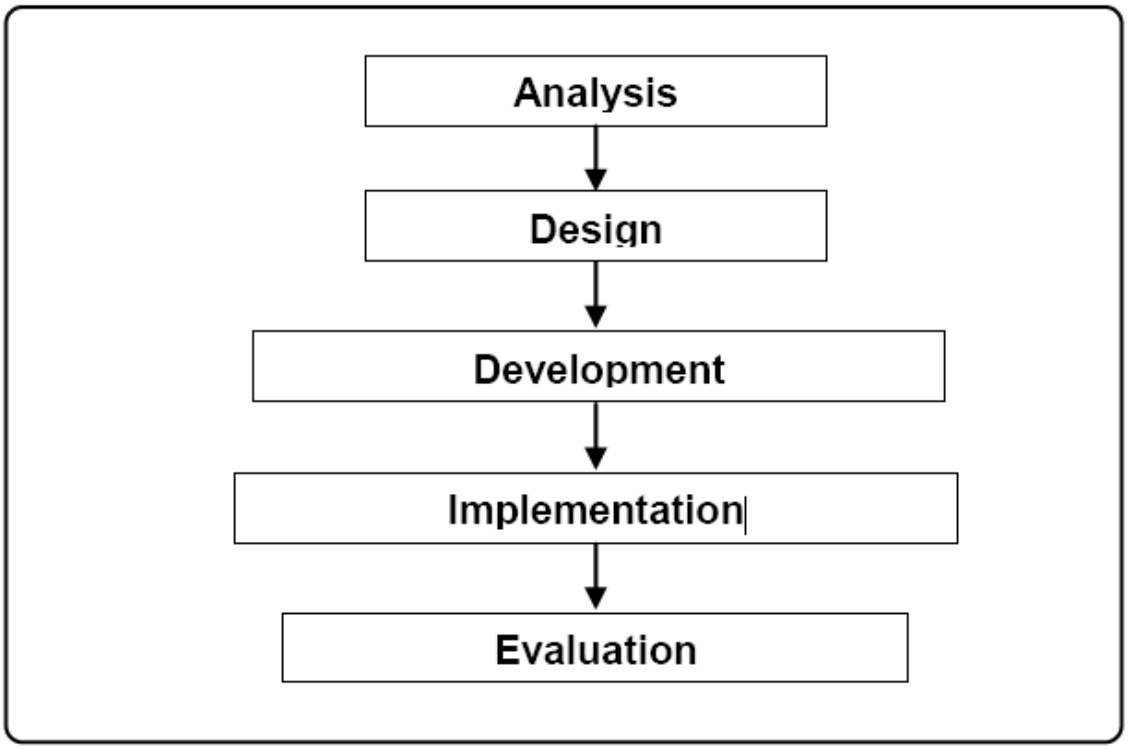

Fig. 2. to ADDIE Model workflow

5.1.1. Analysis

The main concern in the analysis stage is to review the effective learning concept and instructional design theory in developing the C++programming e-content or e-material. Gagne's theory will be used in this process. Gagne's theory of processing information, developing and analyzing the econtent application are the requirements to produce a cognitive teaching and learning concept.

5.1.1.1. Gagne Theory

According to Gagne's theory, there are nine main elements in a particular lesson which are as follows:

a) gain attention
b) inform leaner f objective
c) stimulate recall of prior information remembering the previous lesson
d) present inofrmation
e) provide guidance
f) elicit instruction
g) provide feedback
h) assess performance
i) enhance retention and transfer of knowledge and skills

In designing the e-content, the cognitive theory approach is used as follows.

a) The e-content developed must be attractive to the user. In ensuring this atmosphere is achieved,appropriate graphics with multimedia presentation are included in the e-content development tocapture users' attention.
b) Teaching and learning objective statement. According to Gagne's theory, the statement is a motivation for the students to know and understand the intended learning activities. The statementcan be in the form of a text or attractive animated statement. The learning outcomes of the econtentmust be stated as it can encourage the user to continually use the e-content for learning.This will increase the knowledge and skills on C++ programming based on the syllabus.
d) The e-content application can encourage the leaners to continually use and learn. Hence,attractiveelements are added to the application such as functional icons which not only provideinformation, but assistance as well to the user when needed.
e) Challenging exercise, assignment or assessment in the form of objective, subjective questions andquizzes are inserted in the application. The insertion is to appraise as well as understanding thelearners' achievement, and analyzing certain topics during using the application. Positiveresponses to the exercise, assessments are provided in the form of graphic, text, audio and visual.The positive responses will increase learners interests, stimulate and motivate the learners towhich initially they will apply whatever that has been acquired.The users have the opportunity todisplay their ability and competency before moving to the next competency level and they havevarious ways to provide feedback such as through the use of mouse or keyboard. The answers orresponses are time based and the computer will alert the user for assistance, approval to reattemptthe question or move to the question.
f) This application takes into consideration the final evaluation factor of the teaching and learningevents through the exercise activities of answering the objective and subjective questions as wellas the quiz. The application also can provide feedback, diagnosis of weaknesses and strengths of astudent. Such evaluation and feedback is hoped to enhance the retention and assist in theapplication of information ina more challenging learning condition.

5.1.1.2. Cognitivism Theory

The Cognitive theory relates to the short term and long term memory. One of the factor in this theoryis the processing of information used in the computer based learning. This theory supports activelearning where the students actively obtain, organize and study the information to make it meaningful.They require transfer of learning and information as this theory focuses o the previous and currentinformation. The software design should be in symbols and other necessary channel for theinformation to be organized and easily accessible for the students.

5.1.2. Research Design

There are two (2) levels to complete this study. The first level is the design and development of theinteractive multimedia application using the in-laboratory research method and the second level is theapplication analysis using quantitative research method of survey. Sulaiman Shamsuri (2004) statesthat quantitative study helps in clarifying our observation analysis. In other words, numbers andpercentage make it easier for the reader to understand and interpret as numbers involve calculation.This also helps in the collection, comparison and summation.

Both the methods have gone through a few frameworks, which are:

i. Design Method with laboratory study

The application is developed through the use of computer, some selected authoring tools,graphic design software, audio and video software, e-content provider software and the internet. The followings are the outlined framework:

1. Planning and analysis process from the analysis phase for the application requirement thatis the application concept development and data collection regarding the syllabus on theintroduction to computer according to Gagne's theory. This includes the preparation ofthe computer system and related softwares.
2. Application design process to determine the implementation approach, specifications andto develop the flowchart and the storyboard.
3. Application development process that is the construction and development of the contentbased on the storyboard, prototype and its programming.
4. Application implementation process. Execution of the developed application for thelearning purpose.
5. Evaluation of the application. Testing and evaluating the application to meet thespecifications as an interactive multimedia application based on Gagne's learning theoryto support teaching and learning.

ii. Survey Research Method

After the completion of the first phase, a survey will be implemented for the purpose ofgathering the information about the interactive multimedia application. According to SulaimanShamsuri (2004),a study using observation must be done either through a survey or aninterview. Response from the survey is considered the primary data.It is important for the survey at this juncture to ascertain that the design to be developed isaccording to Gagne's theory of learning and the behavioural theory so that the application isdeveloped accordingly in the next phase.

The survey involves the following framework:

1. Design, prepare and distribute the survey through online
2. Identify the respondents who are experts in Gagne's and Cognitive theories
3. Collect data from the survey
4. Analyze the data
5. Discussion on the findings Membuat perbincangan dapatan kajian
6. Provide suggestions recommendations

It is through this framework that the gathered data can be used to evaluate the application'simpact on the learning process.

5.1.3. Research Sample

The subjects chosen for this study is selected through simple random sampling. The target populationis students who are taking the Introduction to Computer Programming at Universiti TeknologiMARA. However the focus is only on the students from the Faculty of Applied Sciences so as to get amore accurate data in fulfilling the aims of the application evaluation.

5.1.3.1. Online Questionnaire

An online questionnaire set according to Gagne's theory the will be prepared after the completion ofthe interactive multimedia application which is to be used to evaluate the effectiveness of theapplication.Being online, the questionnaire is configured to connect with a database. The responses will bestored before being accessed and analyzed. These data is accessible through a portal which also willbe developed.

5.1.3.2. Instrumentation

There are two related instruments used in the data collection for this study, which are interactivemultimedia application based on Gagne's theory of learning and respondents data from an onlinesurvey.

5.1.3.3. Interactive Multimedia Application based on Gagne's theory of learning

This application is considered instrumental that underlines the essence of multimedia technology inthe learning of C++ programming based on Gagne's theory. The impact it brings depends on theaccomplishment of developing the interactive multimedia application that fulfills the need of the learners. The application should be developed according to the skills and creative aspects that could interest the students to learn the material. The survey responses will be used for continuousimprovement purpose.

5.1.3.4. Questionnaire

This second instrumentis also crucial. This questionnaire is targeted at the first year students' (fromthe Faculty of Applies Sciences) responses about the application. These students are taking the7"Introduction To Computer Programming" course. Their responses will give important feedback tothe academicians and researchers about the interactive multimedia application on programming that isbased on the teaching and learning theory.The online questions are prepared according to the actual presentation and actual content of theapplication. Among the information required are:

i. Background
   The respondents are required to register when they access the website. The information likepersonal biodata such as name, faculty, gender, email address, and the registration for ausername and password, are requested for the purpose of data integrity and analysis.

ii. Evaluation of the Application
   The respondents have to use the interactive multimedia application, that is based on Gagne'slearning theory, for two (2) months before attempting the evaluation.This section involves the application development process regarding the multimedia elementsand interactivity contained in the application. The facets of the evaluation are design, impact onthe usage of texts, graphics, color, audio, video, animation and other factors from Gagne'slearning theory. The outcome of the evaluationis used to further improve the application.The respondents are required to choose from a four item Lickert scale of highly agree, agree,disagree and highly disagree for the followings:
   - Interesting screen design.
   - Texts are legible.
   - Graphics are interesting and effective.
   - Choice of colors is effective.

- Audio is used effectively.
- Video is used effectively.
- Animation helps in learning.
- Sufficient Interactivity.
- Iconsandguidelines are clear and understandable.
- The presentation does not require the facilitator to be present.

iii. Evaluation on the application's content

This section is regarding the content of the application involving the syllabus of the"Introduction To Computer Programming" course. The content isdivided into deveral topicsaccording to the sequence in the syllabus. The respondents' evaluation focuses on the contentoutline, objektif, similarity to the existing syllabus, explanation, examples and a few otherfactors.

The respondents are required to choose from a four item Lickert scale of highly agree, agree,disagree and highly disagree. These are the proposed quetions:

- Content outline is clear.
- Learning objective is clear.
- Content delivery meets the syllabus.
- The content is organized clear.
- The content explanation is sufficient.
- Examples are sufficient.
- Supporting materials are provided.
- The content helps in your understanding of the course.
- The content helps in doing revision.
- Overall, the application is satisfying.

Upon completion, the repsondents will send the data to a designated database for processing.

5.1.4. Data Processing and Analysis

Once collected, the data is put through the Statistical Package for the Social Sciences (SPSS) version11.5 software for analysis purpose. Data will be presented in the form of tables, graphs and both pieand bar charts. Microsoft Excel is also used to prepare a more illustrative data.The data analysis process begins immediately for the findings and inferences. Based on thefindings, discussion and observation are conducted to present some proposals and recommendationsat the end of this study.

5.1.5. Evaluation

Evaluation can be defined as a method to collect, record, analyze and utilize in order to support thelearning process. Its implication on the students is their increased awareness about their achievementlevel in a course and increased involvement in the process of teaching and learning.

The formative evaluation is seen as a system or a method that helps to provide suitable feedbackthus the students can take remedial action through using the developed application. This allowsclosing the loop where the students obtain the most from their test or exam and can improve theirlearning ability and performance in the future.

5.1.5.1. Formative Evaluation Methodology

Generally, the evaluation is conducted during the learning process through the students achievementin quiz, tutorial, exercise, laboratory report or mid term test. The feedback on the evaluation is givenimmediately for a quick action thus indirectly helping the students to gauge their early

comprehension as well as to check on the effectiveness delivery of the multimedia e-content on programming basedon the Gagne's learning theory.

6. Conclusion

The findings of this study is hoped to satisfy the current learning approach to further enhanceandupgrade the students acquisition and retention when dealing with Introducation to ComputerProgramming course. The findings on the theory can be used to provide and develop other applicationthat can assist the students in becoming more interested in other courses offered in Universiti Teknologi MARA.

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